Sub C1

whereby said hydrogen atoms react with said catalyst in said vessel at a pressure less than atmospheric, thereby releasing energy and producing hydrogen atoms having a binding energy of about $E_b = 13.6/n^2\ eV$, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

~~53~~ 2. A cell according to claim ~~52~~ 1, wherein said gaseous catalyst comprises hydrogen atoms having a binding energy of about $E_b = 13.6/n^2\ eV$, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

B3 Aosc C2

~~54~~ 3. A cell according to claim ~~52~~ 1, wherein said cell ~~maintains~~ is the reaction,

Ti 090X

$$mX27.21eV + H\left[\frac{a_H}{m'}\right] + H\left[\frac{a_H}{p}\right] \to H^+ + e^- + H\left[\frac{a_H}{(p+m)}\right] + [(p+m)^2 - p^2 - (m'^2 - 2m)]X13.6eV$$

$$H^+ + e^- \to H\left[\frac{a_H}{1}\right] + 13.6\ eV$$

$$H\left[\frac{a_H}{m'}\right] + H\left[\frac{a_H}{p}\right] \to H\left[\frac{a_H}{1}\right] + H\left[\frac{a_H}{(p+m)}\right] + [2pm + m^2 - m'^2]X13.6eV + 13.6eV$$

where m and p are positive non-zero integers, m′ is an integer greater than 1, and a_H is the radius of the hydrogen atom (n=1).

Sub C3

55. A cell according to claim 52, whereby said gaseous hydrogen atoms are formed in the cell by reacting

molecules containing hydrogen atoms, and

Sub C3

~~a second catalyst for disassociating said molecules to produce hydrogen atoms.~~

~~56. A cell according to claim 55, wherein said second catalyst is at least one element selected from the group consisting of transition elements and lanthanides.~~

~~57~~ 6. A cell according to claim ~~55~~ 4, wherein said second catalyst is at least one element selected from the group consisting of the refractory metals, activated charcoal, platinum, palladium, gold, rhenium and iridium.

B3

~~58~~ 7. A cell according to claim ~~55~~ 4, further comprising a valve for controlling the flow of said molecules over said second catalyst.

Sub C4

~~59. A cell according to claim 52, wherein said gaseous catalyst is adapted to sublime, boil, or volatilize when heated.~~

~~60~~ 9. A cell according to claim ~~52~~ 1, wherein said gaseous catalyst is formed from a salt.

~~61~~ 10. A cell according to claim ~~60~~ 9, wherein said salt is selected from the group consisting of halides, sulfates, phosphates, carbonates, hydroxides, and sulfides.

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11 ~~62~~. A cell according to claim 9 ~~60~~, wherein said gaseous catalyst is formed from a salt of rubidium or potassium.

12 ~~63~~. A cell according to claim 11 ~~62~~, wherein said salt of potassium is selected from the group consisting of KF, KCl, KBr, KI, K_2S_2, KOH, K_2SO_4, K_2CO_3, K_2PO_4, and K_2GeF_4.

13 ~~64~~. A cell according to claim 11 ~~62~~, wherein said salt of rubidium is selected from the group consisting of RbF, RbCl, RbBr, RbI, Rb_2S_2, RbOH, Rb_2SO_4, Rb_2CO_3, and Rb_3PO_4.

14 ~~65~~. A cell according to claim 1 ~~52~~, wherein said gaseous catalyst comprises a cation having a vapor pressure greater than zero when said gaseous catalyst is heated, said cation being selected from the group consisting of (K^+), (Rb^+), (Mo^{2+}), and (Ti^{2+}).

15 ~~66~~. A cell according to claim 1 ~~52~~, wherein said gaseous catalyst comprises a pair of cations having a vapor pressure greater than zero when said gaseous catalyst is heated, said pair of cations being selected from the group consisting of: (Sn^{4+}, Si^{4+}), (Pr^{3+}, Ca^{2+}), (Sr^{2+}, Cr^{2+}), (Cr^{3+}, Tb^{3+}), (Sb^{3+}, Co^{2+}), (Bi^{3+}, Ni^{2+}), (Pd^{2+}, In^+), (La^{3+}, Dy^{3+}), (La^{3+}, Ho^{3+}), (K^+, K^+), (V^{3+}, Pd^{2+}), (Lu^{3+}, Zn^{2+}), (As^{3+}, Ho^{3+}), (Mo^{5+}, Sn^{4+}), (Sb^{3+}, Cd^{2+}), (Ag^{2+}, Ag^+), (La^{3+}, Er^{3+}), (V^{4+}, B^{3+}), (Fe^{3+}, Ti^{3+}), (Co^{2+}, Ti^+), (Bi^{3+}, Zn^{2+}), (As^{3+}, Dy^{3+}), (Ho^{3+}, Mg^{2+}), (K^+, Rb^+), (Cr^{3+}, Pr^{3+}), (Sr^{2+}, Fe^{2+}), (Ni^{2+}, Cu^+), (Sr^{2+}, Mo^{2+}),

B3

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(Y^{3+}, Zr^{4+}), (Cd^{2+}, Ba^{2+}), (Ho^{3+}, Pb^{2+}), (Pd^{2+}, Li^{+}), (Eu^{3+}, Mg^{2+}), (Er^{3+}, Mg^{2+}), (Bi^{4+}, Al^{3+}), (Ca^{2+}, Sm^{3+}), (V^{3+}, La^{3+}), (Gd^{3+}, Cr^{2+}), (Mn^{2+}, Tl^{+}), (Yb^{3+}, Fe^{2+}), (Ni^{2+}, Ag^{+}), (Zn^{2+}, Yb^{2+}), (Se^{4+}, Sn^{4+}), (Sb^{3+}, Bi^{2+}), and (Eu^{3+}, Pb^{2+}).

16 ~~67~~. A cell according to claim 1 ~~52~~, wherein said gaseous catalyst comprises an ionic compound resistant to reduction by hydrogen atoms.

17 ~~68~~. A cell according to claim 1 ~~52~~, wherein said gaseous catalyst is adapted to provide ions.

B3

Sub C5

69. A cell according to claim 52, whereby said vessel maintains a hydrogen partial pressure of less than about one torr.

70. A cell according to claim 52, wherein said vessel maintains said catalyst in molten form.

71. A cell according to claim 52, wherein the temperature of said vessel is maintained at about 50 °C above the melting point of said gaseous catalyst.

72. A cell according to claim 52, wherein the hydrogen partial pressure in said vessel is maintained at about 200 millitorr.

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Sub C5

73. A cell according to claim 66, wherein the temperature of said vessel is maintained at about 50 °C above the higher melting point of compounds of the two cations comprising said cation pair of said gaseous catalyst.

23

B

74. A cell according to claim ~~52~~, further comprising a valve for ~~selectively~~ releasing said catalyst from said vessel.

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B3 C

75. A cell according to claim ~~52~~, further comprising a valve for ~~selectively~~ releasing said hydrogen atoms having a binding energy of about $E_b = 13.6/n^2 \ eV$, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

Sub C6

76. A cell according to claim 52, wherein the vapor partial pressure of said gaseous catalyst varies with temperature.

26

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77. A cell according to claim ~~52~~, further comprising a heater for heating said vessel.

Sub C7

78. A cell according to claim 52, further comprising a catalyst reservoir communicating with said reaction vessel, said catalyst reservoir containing said gaseous catalyst or a source thereof.

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~~79~~ 28. A cell according to claim ~~78~~ 27, further comprising a heater for heating said catalyst.

~~80~~ 29. A cell according to claim ~~78~~ 27, wherein said catalyst reservoir is external to said reaction vessel.

~~81~~ 30. A cell according to claim ~~80~~ 29, further comprising a flow control valve for controlling the flow of said catalyst from said catalyst reservoir into said vessel.

B3

~~82~~ 31. A cell according to claim ~~52~~ 1, further comprising a chamber for containing hydrogen atoms or a source of hydrogen atoms communicating with said reaction vessel.

~~83~~ 32. A cell according to claim ~~82~~ 31, further comprising a flow control valve for controlling the flow of hydrogen atoms from said chamber into said vessel.

C

~~84~~ 33. A cell according to claim ~~832~~ ~~82~~ 31 wherein said source of hydrogen atoms comprises an internal combustion engine.

Sub C4

~~85. A cell according to claim 82, wherein said source of hydrogen atoms comprises a tungsten capillary heated to between 1800 and 2000 K for dissociating molecules containing hydrogen atoms to produce hydrogen atoms.~~

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35 ~~86~~. A cell according to claim 34 ~~85~~, further comprising a valve for controlling the flow of said molecules over said tungsten capillary.

36 ~~87~~. A cell according to claim 31 ~~82~~, wherein said source of hydrogen atoms comprises an inductively coupled plasma flow tube for dissociating molecules containing hydrogen atoms to produce hydrogen atoms.

37 ~~88~~. A cell according to claim 36 ~~87~~, further comprising a valve for controlling the flow of said molecules into said inductively coupled plasma flow tube.

38 ~~89~~. A cell according to claim 36 ~~87~~, further comprising a power controller for controlling the power dissipated in said inductively coupled plasma flow tube.

39 ~~90~~. A cell according to claim 1 ~~52~~, further comprising a heat exchanger for removing said extracted energy from said cell.

40 ~~91~~. A cell according to claim 1 ~~52~~, further comprising a power gauge for measuring the amount of extracted power ~~energy~~ in said cell.

92. A method for extracting energy from hydrogen comprising the steps of:

Sub C9

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Sub C9

providing a gaseous catalyst having a net enthalpy of reaction of about 27 * (p/2) eV, where p is an integer greater than 1;

providing gaseous hydrogen atoms; and

reacting said gaseous catalyst with said gaseous hydrogen atoms, thereby producing hydrogen atoms having a binding energy of about $E_b = 13.6/n^2\ eV$, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1,

said reaction occurring at a pressure less than atmospheric pressure.

33

146 ~~93~~. A method according to claim 145 ~~92~~, wherein said gaseous hydrogen atoms are provided by disassociating molecules containing hydrogen atoms.

147 ~~94~~. A method according to claim 145 ~~92~~, wherein gaseous hydrogen atoms are provided by contacting molecules containing hydrogen atoms with a second catalyst ~~catalyst~~ for disassociating said molecules to produce hydrogen atoms in the gas phase.

148 ~~95~~. A method according to claim 145 ~~92~~, wherein said gaseous catalyst comprises gaseous hydrogen atoms having a binding energy of about $E_b = 13.6/n^2\ eV$, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

149 ~~96~~. A method according to claim 145 ~~92~~, wherein said gaseous catalyst is provided according to the reaction,

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T1170X

$$m\,X\,27.21\,eV + H\left[\frac{a_H}{m'}\right] + H\left[\frac{a_H}{p}\right] \rightarrow H^+ + e^- + H\left[\frac{a_H}{(p+m)}\right] + [(p+m)^2 - p^2 - (m'^2 - 2m)]\,X\,13.6\,eV$$

$$H^+ + e^- \rightarrow H\left[\frac{a_H}{1}\right] + 13.6\ eV$$

$$H\left[\frac{a_H}{m'}\right] + H\left[\frac{a_H}{p}\right] \rightarrow H\left[\frac{a_H}{1}\right] + H\left[\frac{a_H}{(p+m)}\right] + [2pm + m^2 - m'^2]\,X\,13.6\,eV + 13.6\,eV$$

where m and p are positive non-zero integers, m′ is an integer greater than 1, and a_H is the radius of the hydrogen atom (n=1).

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~~97~~ 150. A method according to claim ~~92,~~ 145 wherein said gaseous catalyst is provided by volatizing a material to a gaseous state and ionizing said gaseous material.

~~98~~ 151. A method according to claim ~~92,~~ 145 wherein said hydrogen atoms are provided by flowing gaseous molecules containing hydrogen atoms over a hot refractory metal, transition metal, platinum, palladium, gold, rhenium, or iridium.

~~99~~ 152. A method according to claim ~~92,~~ 145 wherein said hydrogen atoms are provided by flowing gaseous molecules containing hydrogen atoms over a tungsten capillary heated by electron bombardment to between 1800 and 2000 K.

153 145

1~~0~~0. A method according to claim ~~92~~, wherein said hydrogen atoms are provided by flowing gaseous molecules containing hydrogen atoms in an inductively coupled plasma flow tube.

154 145

1~~0~~1. A method according to claim ~~92~~, wherein said reaction occurs at a pressure less than about one torr.

155 145

1~~0~~2. A method according to claim ~~92~~, wherein the partial pressure of hydrogen atoms in the reaction is less than about one torr.

156 145

1~~0~~3. A method according to claim ~~92~~, wherein the partial pressure of hydrogen atoms in the reaction is about 200 millitorr.

104. A method according to claim 92, wherein the partial pressure of the gaseous catalyst in the reaction is between about 50 and 250 millitorr.

157 145

1~~0~~5. A method according to claim ~~92~~, wherein said reaction occurs at a temperature of about 50 °C above the melting point of said gaseous catalyst.

158 145

1~~0~~6. A method according to claim ~~92~~, wherein the vapor partial pressure of said gaseous catalyst is controlled by varying the temperature of said gaseous catalyst.

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